agricultural research

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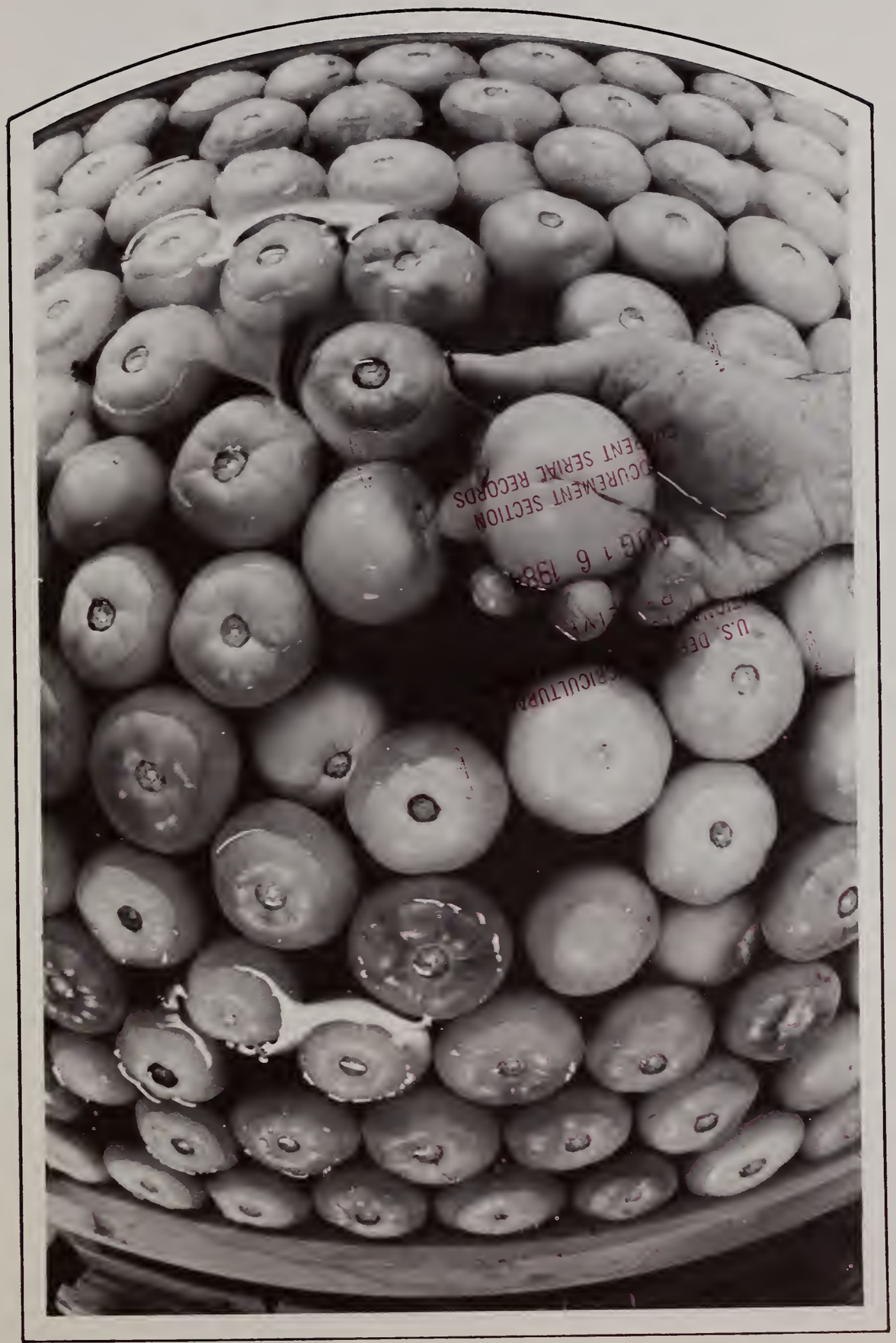

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October 1977/Vol. 26, No. 4

You've Come A Long Way, Bossy

The "contented" cow plodding placidly through the meadow is truly one of nature's marvels.

For countless ages, the cow has grazed on whatever pasture was available. She instinctively knew which plants—from the great array available in any field—would nourish her, as well as permit her to manufacture enough milk to feed her calf.

The cow smoothly and efficiently converts grass and other humanly inedible forages and food processing byproducts into meat and milk.

Today's dairy cows have been bred to give much more milk than their calves could ever require.

Cows in our better dairy herds commonly average 13,000 pounds—or 6,500 quarts—of milk per year. The all-time production record is held by an Indiana cow (Beecher Arlinda Ellen), who last year gave 56,500 pounds (28,250 quarts) of milk. During her peak, she was relieved of 95 quarts of milk per day.

In modern automated milking parlors, machines vacuum the milk, via the cow's teat, from the highly complex mammary gland.

When this gland becomes infected with mastitis, however, milk production plummets. Mastitis is recognized worldwide as one of the most costly diseases of dairy cattle. Many dairy producers do not fully recognize the tremendous losses sustained through unrealized milk production.

Currently, mastitis research is being done in the United States at 22 locations, under 43 projects. This represents about $1.3 million in Federal and $1.4 million in State funds. The results of just one of these projects is reported on page 12 of this issue.

More and more, scientists are required to justify research from a cost-benefit standpoint. With mastitis, if research can reduce economic losses 2 percent per year ($26 million) for the next 10 years, and if research expenditures remain constant, the benefit-cost ratio will be 9.6 to 1. A 4 percent reduction in losses would make the ratio 19.2 to 1.

These figures wouldn't interest either an old-fashioned or a modern dairy cow. Quite frankly, nothing except the prospect of food piques her interest. But, agricultural research, such as that being done on mastitis, concerns all of us. After all, milk is still one of nature's most nearly perfect human foods.—*M.M.M.*

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COVER: Soft rot of tomatoes can be costly to producers and consumers alike. Adding chlorine to the water at the dump tank and spray wash sites in tomato packing houses has proven an effective method of controlling this decay (0677X729–27A). Article begins on page 8.

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Dr. Cathey compares a 4-month-old vegetative geranium plant grown under natural greenhouse conditions with flowering geraniums of the same age grown under a combination of natural greenhouse light and high pressure sodium lamps. Commercial greenhouses generally start their geraniums with cuttings rather than seed because flowering time from seeds takes 15 to 20 weeks. However, sodium lighting in combination with incandescent lighting or reduced levels of sunlight can condense that time to 9 weeks—thus making it practical for commercial greenhouses to start geranium plants from seed (0677X737–7A).

Sodium Lamps . . . Better Than Fluorescent

COMMERCIAL NURSERYMEN and florists who wish to accelerate the propagation stage of plants in growth chambers or to supplement sunlight in greenhouses often consider cool-white fluorescent (CWF) lamps or CWF in combination with incandescent (CWF + I) lamps the most efficient artificial lighting available.

Low pressure sodium (LPS) and high pressure sodium (HPS) lamps, however, are more effective than CWF for starting plants and could give growers substantial increases in plant yields and savings in energy costs, according to ARS research at the Beltsville Agricultural Research Center (BARC).

Dr. Henry M. Cathey, Chief of BARC's Florist and Nursery Crops

Electrical engineering technician Stanley P. Holliday uses a footcandle meter to measure both direct and ambient light falling on the plants (0677X732–17A).

Laboratory and Lowell E. Campbell, Chief of BARC's Agricultural Equipment Laboratory (Rm. 101, Bldg. 004, BARC–West, Beltsville, MD. 20705) found LPS and HPS lamps superior to CWF by a series of comparative tests in plant growth chambers and greenhouses.

Specially constructed to match the most advanced starting techniques, the BARC experimental growth chambers controlled temperature, humidity, and the gaseous content of the air. The chambers also misted and fed the plants at regular intervals.

The only variable was light. In separate chambers lit by LPS, LPS + I, HPS, HPS + I, CWF, or CWF + I lamps, Dr. Cathey and Mr. Campbell grew "Great Lakes" lettuce and "Pink Cascade" petunias, which they had selected to represent most cultivated crop plants.

After 15 days, plants grown under LPS + I lamps were the most advanced in growth. Petunias grown under LPS + I had 53 percent more fresh weight than petunias grown under CWF, and 38 percent more than those under CWF + I lamps. Petunias under LPS + I were also taller and had a few more nodes than those grown under the other lamps. Petunias grown under HPS + I were 8 percent more advanced than those under CWF + I.

Lettuce plants grown under LPS + I were 27 percent taller and approximately equal in fresh weight to those grown under CWF or CWF + I.

The addition of incandescent light enhances the horticultural effects of LPS, HPS, and CWF lamps. Light comprised of wavelengths between 700 to 850 nm (namometers, 10^{-9}m) and supplied only by I lamps, or by sunlight, is required by most plants for stem elongation, increased fresh weight, and early flowering and fruiting.

Artificial lighting is commonly used in commercial horticulture for controlling daylength, and thus producing flowers, for example, for seasonal sales. In related tests, Dr. Cathey and Mr. Campbell compared LPS + I, HPS + I, and CWF + I lamps on seedlings grown in different photoperiods of light (e.g. 8 hours of light, 16 hours of dark).

The results showed that fresh weights of petunias grown under LPS + I were 20, 94, 146, and 64 percent heavier than for those grown under CWF + I for photoperiods of 4, 8, 16, and 24 hours, respectively. Fresh weights for those under HPS + I were 64, 84, and 13 percent heavier than CWF + I lit petunias in photoperiods of 18, 16, and 24 hours respectively.

Plant growers hit with high bills for lighting may want to convert to LPS or HPS lamps. Dr. Cathey and Mr. Campbell discovered that LPS + I lamps are 8 percent more energy efficient than CWF + I, 36 percent more efficient than LPS without I, and 51 percent more efficient than CWF without I. These percentages show efficiency expressed in watts per square meter at 0.25 meter above test plants. The ARS researchers found that HPS + I are approximately equal to CWF + I in efficiency. However, where acceptable and useable, growers might go to HPS + I for the additional heat radiated from HPS lamps.

Because LPS lamps are tubular in shape, they can be used in designs similar to those for CWF lamps, say the researchers. But HPS lamps require a different type of reflector—parabolic in shape as opposed to the linear reflectors which are used for CWF or LPS.

LPS lamps also produce more light per lamp than do CWF. Dr. Cathey and Mr. Campbell found that three 180

watt LPS lamps can light an area that would take eight 115-watt CWF lamps. HPS lamps have a similar efficiency. Thus, LPS lighting or HPS lighting could reduce costs for the grower by requiring less power, less wiring, and, for supplementing natural light in greenhouses, LPS or HPS fixtures will cause less shading of crops.

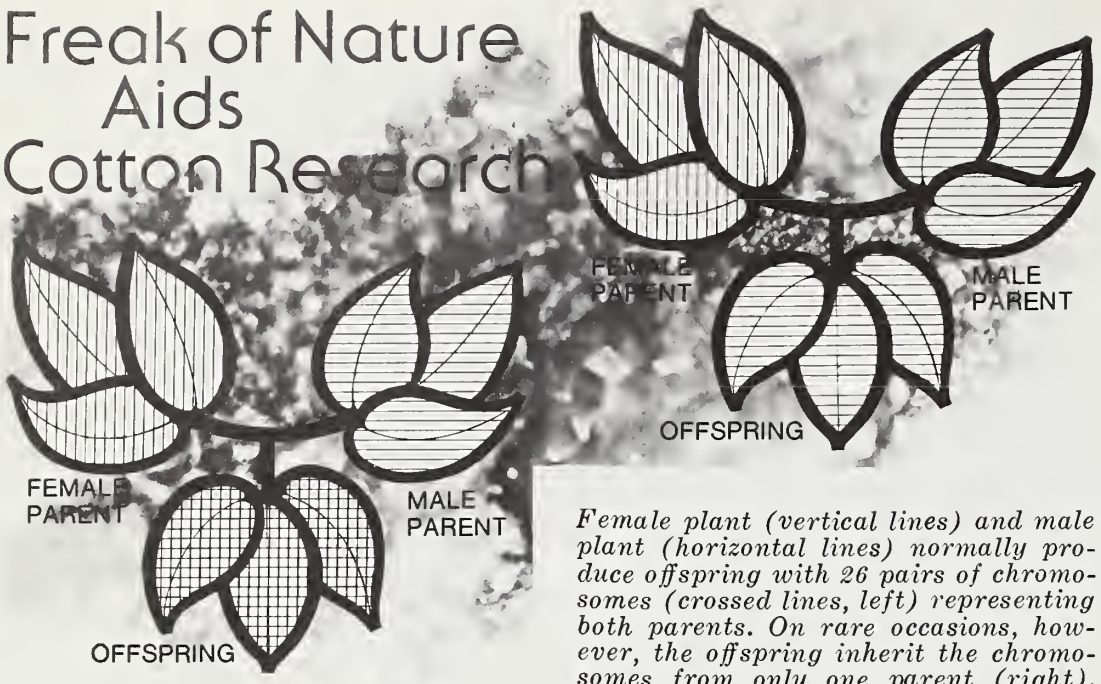
Artificial light is often used in greenhouses to supplement dim winter light. The two BARC lab chiefs compared the growth of over 100 species of plants, receiving 16 hours of supplemental LPS or HPS lighting in greenhouses, to the same species grown under CWF + I lamps and all the cultural advantages of growth chambers (CWF + I are the most commonly used lamps for commercial growth chambers.) All species grew as well under LPS and HPS supplemental greenhouse lighting as in the growth chambers.—*S.M.B.*

Above: *These lettuce plants held by Dr. Cathey were grown in chambers designed to provide totally controlled environments. In this experiment, all conditions were the same—except for lighting. The larger plant received light from low pressure sodium lamps and incandescent lamps. The smaller plant was grown under low pressure sodium light only (0677X737–30A).*

Below: *Mr. Holliday changes lamps in one of the "easy access" growth chamber tops he designed to facilitate lighting control. Such tops afford greater flexibility to scientists investigating how various light sources affect plants (0677X738–5).*

Above: *Each of the experimental growth chambers is equipped to control light, temperature, humidity, and gaseous content of the air. Mr. Holliday adjusts a light control relay timer for one of the chambers. Uncovered tank in foreground shows where air flows through water spray and across heaters to control humidity and air temperature (0677X739–11A).*

Freak of Nature Aids Cotton Research



Female plant (vertical lines) and male plant (horizontal lines) normally produce offspring with 26 pairs of chromosomes (crossed lines, left) representing both parents. On rare occasions, however, the offspring inherit the chromosomes from only one parent (right). Called haploid plants, their single-chromosome structures can be exactly duplicated (through a chemical treatment) into 26 pairs that can then reproduce into a pure line of cotton (PN–4145).

A FREAK OF NATURE in plants called semigamy offers scientists a means of erasing years in the development of pure lines of cotton.

Semigamy, an abnormal type of plant reproduction, occurs when a sperm cell enters an egg cell but fails to fuse or "mate." Instead of fusing to form a normal seed, the male and female nuclei—containing all the hereditary material—divide independently and seed are formed that have sectors of tissue composed of either male or female nuclei. Thus, plants grown from these seeds are sectored for cells of male or female origin, are haploid, and carry only the hereditary material of the parent of origin.

Haploid plants have only half the normal number of chromosomes. Normal cotton cells contain 26 *pairs* of chromosomes while cells of haploid cotton plants contain only 26 *single* chromosomes. When young buds of a haploid plant are treated with colchicine, the chromosome number can be doubled and the reproductive capacity restored. Plants from the seeds of the treated buds are exact genetic duplicates of the parent and are of normal size and fertility.

Doubling a haploid results in a pure line of cotton in one generation regardless of the diversity of the variety from which the haploid was obtained. In contrast, many years are required to stabilize a similar line through pure line breeding involving the plant-to-row procedure of breeding.

Dr. Edgar L. Turcotte, ARS geneticist, and Dr. Carl V. Feaster, ARS agronomist, Western Cotton Research Laboratory (4135 E. Broadway Rd., Phoenix, AZ 85040), discovered semigamy in a unique haploid Pima cotton plant. This particular plant, when doubled, gave progenies with a high incidence of "haploidness"—approximately 50 haploid plants in 100 seeds. Nature produces one haploid in about 10,000 seeds.

The ARS scientists determined that semigamy in Pima cotton is a heritable trait and can be transmitted from parent to progeny. The trait allowed the ARS team to develop a technique to produce haploids at will from any cotton plant source and in a much higher frequency than found in nature. Turcotte and Feaster then incorporated a genetic marker of yellow plant color into the semigametic stock.

Crosses between this coded stock, as female parent, and normal, green cotton as male parent, produces first generation plants that are sectored for haploid, yellow tissue and haploid, green tissue. Such plants are easy to spot. A portion of the plant is yellow and the other portion a deep green. The color sectoring may be among or within the leaves.

Researchers in the United States are now using the yellow, semigametic Pima stock to develop pure lines of both Pima and Upland cotton that have such features as extra-high levels of gossypol for insect resistance. Pure lines developed from doubled haploids also are being used as inbred lines for hybrid cotton production, and as a means to survey gametes—reproductive cells—from first generation plants for new, desirable combinations of traits.

In practice, if an agronomist desired to develop a commercially adapted, high-gossypol variety but had only a high gossypol strain that was unproductive, he could cross the high gossypol strain with an adapted, productive strain. He could then cross the first generation plants, as male, with the semigametic, marked stock, double the chromosome number of the resulting high gossypol haploids with colchicine, and select for productive plants. The selected plants would be pure lines with high gossypol and high production.

If the agronomist didn't take that route but chose instead to adhere to conventional breeding methods, it would take years. He would plant seeds from the first generation, and initiate a plant-to-row breeding procedure, in which he would select for high gossypol and production over the next 3–5 years while establishing a reasonably "pure" line.

"The potential value of the new source of doubled haploids of cotton is still being determined; however, successful use of doubled haploids from other crop plants lends encouragement to cotton researchers," Dr. Turcotte said.

Semigamy may occur in other cultivated crops since it has been found in cotton and several noncultivated plant species.—*J.P.D.*

Above: Dr. Jackson (left) and Dr. Cutlip check sheep for clinical signs of pneumonia after they were inoculated with the progressive pneumonia virus. Blood samples from these sheep were taken every month for the first year after inoculation, and periodically thereafter to check for antibodies (0677X761–33).

***Right:** Biological laboratory technician Judy Bechtum assists Dr. Cutlip in dissecting newborn lambs. The tissue will be examined for the presence of a pneumonia-causing virus to see whether such a virus was tranmitted from the mother to her offspring. Centrifuge tubes (foreground) contain blood samples from the lamb. Red cells are commonly separated from blood serum by centrifugal force, thereby leaving the serum for serologic testing (0677X760–16).*

DIAGNOSTIC TEST DEVELOPED

Progressive Pneumonia in Sheep

PROGRESSIVE PNEUMONIA of sheep may be more prevalent than supposed. A survey with a new diagnostic test indicates 1 to 68 percent of old sheep from different geographic areas were affected at slaughter.

Up to now, tentative diagnosis based on clinical signs could be made only in late stages of the slowly developing disease. Positive diagnosis was possible only at post-mortem examination, based on presence of characteristic lesions.

A serologic (blood antibody) test developed at the National Animal Disease Center accurately detects progressive pneumonia in the absence of clinical signs and opens the way for studies that eventually may lead to control of the disease.

Progressive pneumonia is seen in both farm and range flocks, generally in sheep at least 3 years old. Breathing of affected sheep, commonly called "lungers," gradually becomes more and more labored, they lose weight, and die in several months to a year.

In the survey, ARS veterinary medical officers Randall C. Cutlip and Terry A. Jackson, National Animal Disease Center (P.O. Box 70, Ames, IA 50010), found that incidence in old sheep at slaughter varied by area of origin. Percentage of sheep showing positive reaction to the test, by state of origin, was Idaho, 68; Utah, 45; Colorado, 42; California, 37; Iowa, Minnesota, Nebraska, or South Dakota, 30; Arizona, 29; Oregon, 27; Texas or Oklahoma, 1.

Diseases called by different names in Iceland and Europe are similar if not identical to progressive pneumonia, Dr. Cutlip says, and are caused by the same virus.

Dr. Cutlip and technician Gwen A. Laird isolated virus from diseased lungs of three aged ewes showing typical signs and lesions of progressive pneumonia. Virus growth and reproduction in embryonic sheep lung cells indicated it was the same virus described by previous investigators. The earlier studies showed that this virus produces progressive pneumonia in previously healthy sheep.

The researchers then isolated the virus from lungs of naturally infected sheep, used that virus to infect cell cultures, and then used antigen produced by the cultures in an agar gel immunodiffusion test.

The scientists modified test procedures originally developed at NADC by Dr. Janice M. Miller for detecting bovine leukemia virus in blood samples from cattle. The progressive pneumonia and bovine leukemia viruses are structurally related, and both produce slowly developing disease and lesions.

The blood serum test is reliable and uncomplicated, Drs. Cutlip and Jackson found. With it they detected precipitating antibody in blood samples from all 16 lambs experimentally inoculated with progressive pneumonia virus. Four of the 16 tested positive a month after inoculation, half by the second month, and all 16 by the sixth month. Some tested positive as long as 4 years after infection.

Studies are continuing on progressive pneumonia and its role in the pneumonia complex, the most important group of sheep diseases.—*W.W.M.*

Right: Dissecting scalpel in hand, Biological Laboratory Technician Alice Dow digs out the infected (soft rot) part of a tomato. The sample collected will be used to prepare a bacterial solution that simulates contaminated water in tomato packinghouses (0677X727–11).

Below: To test the effectiveness of chlorinated water against the spread of soft rot, tomatoes must be exposed to precisely measured doses of soft rot bacteria at the principal sites of water contamination. Here, Dr. Segall and Ms. Dow ready a spray washer modified to draw from a flask of soft rot bacteria (0677X729–2A).

Chlorine For Sick Tom

TOMATOES, once called "love apples," are reduced to an unlovable—if not unmarketable—state by a bacterium often present in tomato packinghouse dump tank and washer waters. *Erwinia carotovora* Jones is the bacterium. Chlorine provides the cure.

Since many untreated tomatoes rot during the shipping process, the consumer reaps the savings when tomatoes are treated before they reach the supermarket. Otherwise, with culling, the price goes up.

Plant pathologist Raphael H. Segall and technician Alice Dow at the U.S. Horticultural Research Laboratory (2120 Camden Road, Orlando, FL 32803) determined the most effective methods for control of soft rot with chlorine.

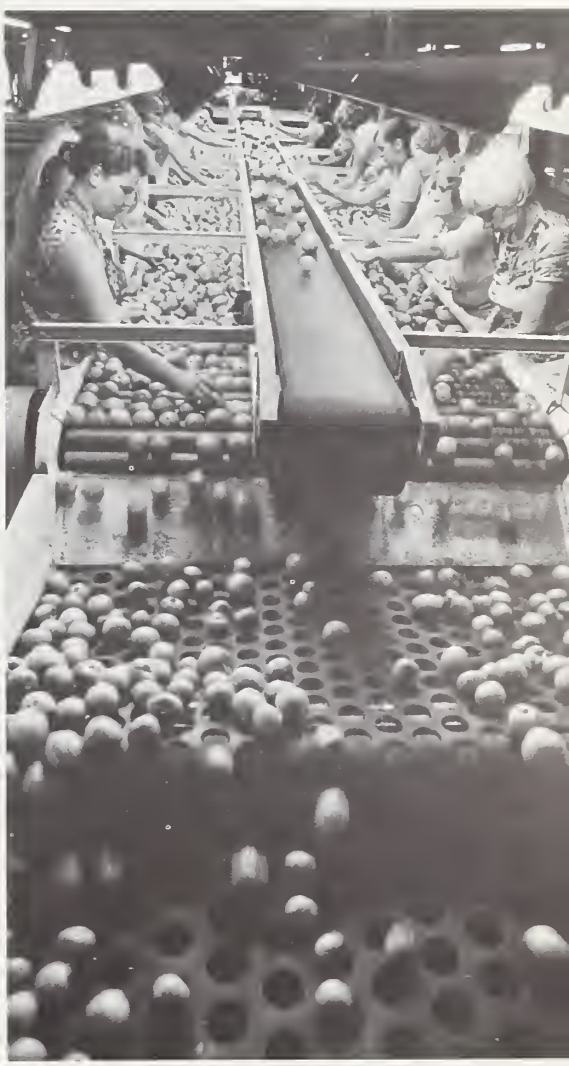
The primary source of inoculation is postharvest exposure to *E. carotovora* in water used for washing. When washing is performed in the field, the water is highly contaminated, and decay incidence of tomatoes washed in this water is very high. When fruit is washed in the packing house, the wash water also is contaminated, and incidence of postharvest decay is high.

In recent years, packinghouses have installed dump tanks containing water to receive tomatoes brought from the field in pallet bins. Researchers have concluded that water in these tanks is also a source of bacterial inoculation.

"By adding chlorine in the form of gas, calcium, or sodium hypochlorite to wash and dump tank water, we can effectively control bacterial soft rot," says Dr. Segall, "but there are some limitations. The chlorine compounds are ineffective when they are added before or after the time the tomatoes are

The dump tank at a tomato packinghouse is one major source of soft rot contamination, and thus an important place for adding chlorine. Dr. Segall and Ms. Dow check the water to determine whether it has enough chlorine to effectively destroy the soft rot bacteria. After a few minutes in the dump tank, the tomatoes are conveyed by rollers up to the packinghouse where they will be spray washed (the other major site for contamination), waxed, sorted, and packaged (0677X730–2A).

***Below:** Inside the packinghouse, tomatoes are spray washed and then conveyed on roller bars past lines of graders. Tomatoes showing signs of soft rot and other defects are put on a conveyor belt that takes them back the other way. (Rejected tomatoes are often used for animal feed.) The rest of the tomatoes pass on to a belt sizer that separates them according to the diameter of the holes they fall through. Because the water at both the dump tank and spray wash sites was chlorinated, only a few of these tomatoes are likely to become infected with soft rot (0677X731–11).*



atoes

actually contaminated, whether that contamination takes place in the dump tank or washer water. And because of the corrosive effect of chlorine on packinghouse equipment, operators of packinghouses would prefer to apply chlorine at only one site, either dump tank or washer."

In the Orlando studies to determine the most efficient method of chlorine application. hand-harvested tomatoes (the popular Walter cultivar) at the mature green stage were obtained from two packinghouses, collected from pallet bins as they came from the field and before they received any packinghouse treatments. The graded fruit was divided at random into 9 lots of 50 fruit each.

Contamination of dump tank water was simulated by maintaining a concentration of 1,000 bacterial cells per milliliter of *E. carotovora* in a 50-gallon tank of water.

The same concentration of bacterial cells was maintained in wash water by injecting these cells in water flowing from a standard high gallonage nozzle. Chlorine was maintained at 100 parts per million by continuously injecting chlorine gas into the dump tank or wash water.

Following these treatments, a petroleum wax commercially used for

waxing tomatoes was brushed on the treated tomatoes in a commercial waxer.

All lots of fruit were held for 2 weeks at 21°C and a relative humidity of 90 percent.

Dr. Segall determined that exposure of tomatoes to soft rot bacteria in contaminated dump tank water increased decay about 15 percent. Exposure to the same concentration of bacteria in the washer water increased the soft rot incidence to 30 percent. In both dump tank and washer water, decay exceeded 35 percent.

Chlorination made the difference. In the dump tank water, chlorination eliminated contamination. Tomatoes treated in the chlorinated water developed less than 2 percent decay—about the same rate as fruit washed in noncontaminated and nonchlorinated water, thus allowing safe arrival of the tomatoes at the supermarket.

Reductions in decay were similar when contaminated wash water or contaminated dump tank and washer water were chlorinated.

Adding chlorine to water at the site of bacterial contamination was very effective, and compared favorably to washing tomatoes in noncontaminated water.

Dr. Segall reports chlorine was found to be ineffective in controlling postharvest decay when applied before or after exposure of tomatoes to the bacteria; decay incidence ranged from 18 to 24 percent.

The data—of importance to consumers—emphasize that chlorine is effective in preventing bacterial soft rot in dump tank or washer waters, specifically at the site of contamination. —*P.L.G.*

Where it begins: soft rot develops in the field, and a few diseased tomatoes could accidentally be included in the harvest. Dr. Segall examines tomatoes which, although already picked, reveal signs of soft rot. These tomatoes would have reached the packinghouse and contaminated the dump tank or wash water, and thereby the other tomatoes in the same water. By chlorinating that water, however, the soft rot bacteria are killed and the likelihood of further infection is reduced to almost zero (0677X733–7A).

Flu Pandemics-- Where Do They Come From ?

FLU, INFLUENZA, "THE BUG" . . . whatever it is called, the mere mention of the name sends millions of people running to their doctors to get the latest "shot" against this disease. Influenza is the only remaining "pandemic" disease of humans; that is, a disease which rapidly affects large numbers of people in various parts of the world. An epidemic, on the other hand, limits itself to one locality or country.

The odd thing about the flu, which has puzzled scientists for years, is just where all these different strains of the disease originate. Why one year do we have the "Hong Kong" flu, another year, the "Asian" flu; and so on; with pandemics occuring about every 15 years causing untold suffering to millions as well as death to thousands of people? And, unfortunately, inoculation against one form of the flu does not guarantee protection from the next type that comes along.

Now, however, scientists are beginning to get a hint of just where these various forms of flu come from. Research conducted cooperatively between ARS' Plum Island Animal Disease Center, off the coast of Long Island, N.Y., and St. Jude's Childrens Research Hospital, Memphis, Tenn., lends credence to one theory that new forms of flu arise from recombination of influenza viruses. These "recombinant" viruses, which contain parts of the parent viruses, originate from viruses of birds, lower mammals and man. Since these are new viruses, there are no antibodies in the blood to protect a person from the viruses, and no vaccines against them; hence the pandemics. The recombinant viruses could also lead to new flu strains affecting domestic animals.

Research on the recombination and spread of flu viruses was conducted by immunologist Dr. Robert G. Webster from St. Jude's and microbiologist Dr. Charles H. Campbell who is with the Plum Island Animal Disease Center (P.O. Box 848, Greenport, Long Island, NY 11944). All experiments were carried out on Plum Island because the facilities there are among the safest in the world for working with infectious viruses.

In the first research on recombinant viruses, pigs and turkeys inhaled three different viruses. From these animals the scientists were able to isolate new, recombinant viruses different from any of the original three viruses. This initial research demonstrated that it was possible to generate new viruses through recombination in a living animal.

Later research showed that not only could new viruses develop in birds and mammals, but that these viruses could then be naturally transmitted from one animal to the other. This transmission was demonstrated in an experiment in which one group of turkeys was infected with fowl plague virus and the other with turkey influenza virus. These viruses were transmitted naturally to other turkeys in which recombination occurred. The resulting recombinant viruses produced a "mini-epidemic" among the turkeys.

In another project, one pig in a herd was infected with the virus responsible for the human "Hong Kong" flu pandemic of 1968 and another pig with pig influenza virus. Within a week, pigs in the herd carried recombinant viruses as well as the original viruses.

From their experiments, Drs. Campbell and Webster have learned several other interesting facts about influenza viruses. They found, for instance, that turkeys can have two different influenza infections at the same time—one in the upper respiratory tract, another in the lower respiratory tract. These two different infections provide a perfect situation for recombination of the viruses to take place.

Also, dual infections can cause a "sparing" effect, whereby the highly infectious virus fails to kill the bird or takes longer to do so because of the opposition of a second, less infectious virus. The scientists also found that the recombinant viruses may become more numerous than the original viruses in an infected bird.

Although these and other experiments have shown that viruses of man, birds, and lower animals can recombine and form new viruses, Dr. Campbell stresses that this theory has not been proved in nature and that it is still just that—theory.

If further experimentation proves out, however, and the theory of recombinant viruses can be shown to occur in nature, it might be possible to stem the next global flu pandemic. To do this, scientists would have to collect specimens of each form of influenza virus identified in nature. Then, when a new virus appeared, it could be compared with those in the "virus bank" and the origin of the new virus determined. Thus, researchers would have a reference for making a vaccine to head off the next pandemic.—*M.E.N.*

Biological laboratory technician Arlen Anderson (left) helps Dr. McDonald set x-ray machine to expose a teat canal that has been infused with barium sulfate. The bright, tiny white square attached to the teat is radiographic film in a waterproof pack commonly used by dentists. Dental packs proved to be the perfect size for these experiments. Prior to taking the picture, the teat must be immobilized with a rod extending to the floor. This will ensure a picture sharp enough for accurate measurements of the teat canal width (0677X762–9).

Understanding Mastitis Susceptibility

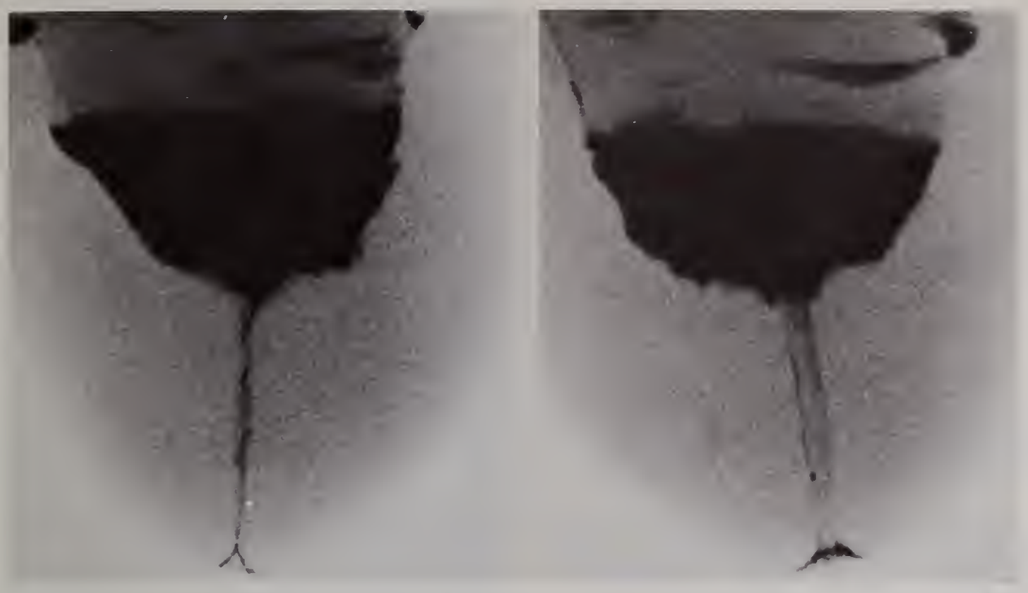
WHY ARE SOME COWS more susceptible to mastitis than others? Why do infections seem to increase as cows get older? Why is susceptibility greater immediately after milking? These questions have a common answer: relative width of teat canals.

When the teat canal diameter is larger than average, ARS veterinary medical officer John S. McDonald found, the milk gland is more susceptible to mastitis. Teat canal length was found to have no bearing on susceptibility to infection. Dr. McDonald is at the National Animal Disease Center (NADC), (P.O. Box 70, Ames, IA 50010).

Teat canals dilate (widen) in each succeeding lactation, Dr. McDonald found, and this dilation helps explain why older cows are more mastitis-prone.

Teat canals were dilated when the milking machine was removed, in another study at the NADC, but had returned to premilking width 2 hours later. Because microorganisms can easily pass through a dilated canal, Dr. McDonald recommends that cows be fed immediately after milking. This will minimize contamination by keeping the cows standing.

Teat canal width is an inherited characteristic. Reducing susceptibility to mastitis by culling cows with wide-diameter teat canals would therefore be possible, but is not practical, Dr. McDonald said. Such cows are also the easiest to milk, an essential trait in automated milking parlors. Instead, Dr. McDonald recommends a mastitis prevention program supplemented by



Above: X-ray photographs clearly show how a cow susceptible to mastitis has a considerably wider teat canal (right) than does a cow resistant to udder infection. In order to measure the differences with significant precision, the x-ray photographs were enlarged ten times and measurements of the photograph were made on different days by the same people and by different people as well. Such cross-checking was necessary to verify the accuracy of the measurements and thereby the reported differences in teat canal width (PN–4144).

***Below:** Dr. McDonald infuses ½ ml. of concentrated barium sulfate into a teat canal. This procedure carries a high risk of new infection; hence, the teat is dipped into a strong disinfectant about 15 to 20 minutes prior to infusion (0677X757–17).*

treatment as needed.

He determined teat canal dimensions by a radiographic (X-ray) technique permitting repeated measurements. Most previous studies of teat canal anatomy were done at post-mortem examination. He first infused dilute barium sulfate into the teat, then made radiographic exposures on dental film. The exposed radiographs were enlarged by conventional photographic methods for detailed study.

Dr. McDonald found marked changes in canal width in five cows observed through four lactations. Average increases were 87.8 percent at the upper end of the canal, 53.1 percent in the middle, and 84.6 percent at the lower end. This study suggested a relationship between increased canal width and lowered resistance to bacterial invasion.

Microscopic examination confirmed that teat canals of quarters previously shown to be susceptible to mastitis were larger and more irregular in cross-section diameter than teat canals of resistant quarters.

Dr. McDonald found correspondingly large changes in teat canal width during the first lactation. Radiographs made at monthly intervals on five cows indicated dilation is most rapid in the first 3 months and last month of lactation. He says dilation of the lower end of the canal is probably a result of tissue stretching during milking. Increasing pressure from weight of milk between milkings probably causes dilation in the upper part of the canal.

Susceptibility to bacterial invasion immediately after milking was demonstrated in a comparison of radiographs made immediately after milking four cows and 2, 4, 6, and 8 hours later. Canals were dilated, particularly in the lower and middle segments, immediately after the machine was removed but were constricted 2 hours later. Dilation, greatest at the upper end, occurred in the next 6 hours.

Another study by Dr. McDonald showed a cause and effect relationship between teat canal width and susceptibility to mastitis. Quarters with new infections after experimental exposure to *Aerobacter aerogenes*, *Streptococcus agalactiae*, or *Staphylococcus aureus* usually had larger than average teat canal diameters. Incidence of new infections was proportionately greater with larger diameter.

In this study, Dr. McDonald exposed teats to one or two types of bacteria 5 days a week. In lactating cows, new infections occurred in 20 of 48 quarters in 13 weeks in one test and 26 of 92 quarters in 6 weeks of a second test. In a group of dry cows, 17 of 36 quarters had new infections in 3 weeks.—*W.W.M.*

Demonstrating the relationship between teat canal width and mastitis susceptibility has been a long process requiring careful records and repeated testing. Dr. McDonald began measuring teat canals with X-ray photographs over 15 years ago. At first, both length and width were evaluated, but length is now discounted in the relationship studies (0677X759–4A).

Right: Technician C. D. Anderson weighs feed material containing a precise amount of aflatoxin. Protective measures such as rubber gloves and mask prevent contact with this particular mycotoxin which could conceivably have an effect on man as well as animals. The production of aflatoxin and its introduction into the animal feed is, essentially, one side of the story . . . (0577X580–19A). ***Far right*** *. . . the other side is the cultivation of bacterial organisms intended for infecting the animals to evaluate how aflatoxins affect their disease immunity and resistance. Here, Dr. Wood examines a culture that will later be injected into a test animal (0577X581–29A).*

Chronic Effects of Mycotoxins on Animals

LIVESTOCK AND POULTRY losses from mycotoxins are like an iceberg. We see only what's on the surface—the acute, dramatic effects when animals consume large amounts of toxin produced by fungi.

A major part of the mycotoxin problem is beneath the surface, says ARS veterinary medical officer Allan C. Pier, National Animal Disease Center (P.O. Box 70, Ames, IA 50010). It remains obscure because the effects of continued low-level toxin consumption are variable and undramatic.

These chronic effects include impaired resistance to infections, reduced effectiveness of immunization, reduced weight gains, lowered production and, possibly, tumor formation. The extent of these losses is just beginning to be documented.

A study at the Center, for example, furnishes evidence linking low levels of aflatoxin, the most intensively studied of the mycotoxins, with impairment of both acquired immunity and resistance to disease in swine.

The investigation, by ARS veterinary medical officers Sigmund J. Cysewski and Richard L. Wood, involved four groups of six pigs each—two groups on a normal diet and two on a diet containing aflatoxin. The researchers gave one group on each diet a single injection of a swine erysipelas bacterin and challenge-exposed all 24 pigs to virulent *Erysipelas rhusiopathiae* 21 days later.

Consumption of aflatoxin interfered with development of acquired resistance to erysipelas in the vaccinated pigs, Dr. Cysewski and Dr. Wood report. Five pigs on the aflatoxin diet were classified susceptible and one partially immune after vaccination. Of the vaccinated pigs on normal diet, three were immune, two were partially immune, and one was susceptible.

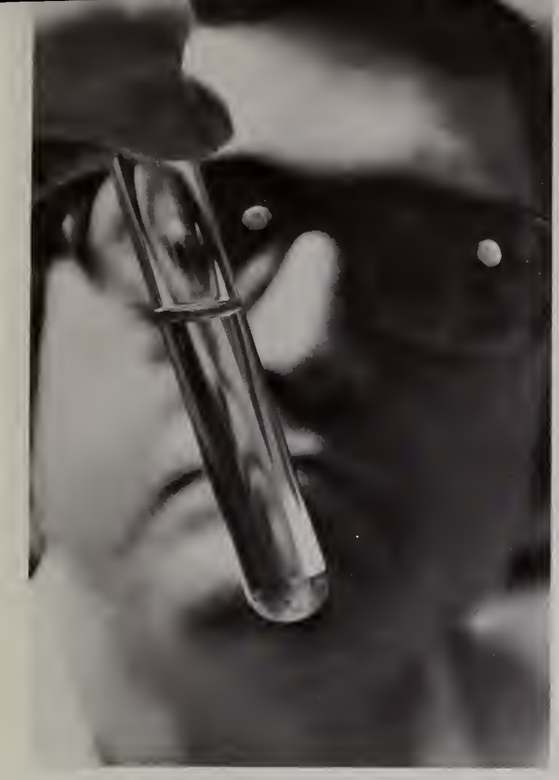
Aflatoxin also appeared to increase the severity of erysipelas infection in the unvaccinated pigs. All six pigs on aflatoxin diet proved susceptible when exposed to the erysipelas organism; two pigs on the normal diet were partially immune and four were susceptible.

The effects of aflatoxin on immunity and resistance to microbial invasions seem to vary according to animal species and disease agent involved, Dr. Pier says. Most studies have involved poultry. In an earlier study, NADC investigators found that 0.25 to 0.5 parts per million aflatoxin in poultry feed reduced acquired immunity to fowl cholera. Other workers have reported reduced resistance to infection by disease agents of coccidiosis, candidiasis, and *Salmonella* infections in poultry consuming aflatoxin. Studies by USDA's Agricultural Research Service at NADC did not demonstrate reduced resistance to Newcastle disease or aspergillosis in turkeys.

Timing of aflatoxin consumption, whether before, during, or after immunization of turkeys to fowl cholera, appeared to be important in studies by Dr. Pier and Kenneth L. Heddleston. When they fed aflatoxin during or immediately after the immunization period, acquired resistance was impaired. If aflatoxin consumption was discontinued before immunization began, adequate immunity to fowl cholera resulted. The defense mechanism impaired by aflatoxin in turkeys has not been identified conclusively. Reduced resistance was not associated with lowered production of antibodies.

The chronic effects of mycotoxins other than aflatoxin are still to be explored, as are the effects of naturally occurring combinations of mycotoxins on animals. Meanwhile, about 100 fungi that grow on standing crops or stored feeds are known to produce toxic substances when conditions are right.

About 20 of the toxins have been associated with naturally occurring diseases of humans or animals. Both the disease and the toxin are well defined for nine of these, Dr. Pier says. Other animal diseases are thought to be caused by mycotoxins, but the specific toxin has not been identified.



Much of the mycotoxin problem in poultry and livestock has been associated with stored grain and other concentrate rations, particularly high-moisture corn, silage, peanuts, and cottonseed meals. Many mycotoxins survive heat and feed processing. Most of the mycotoxins are not antigenic so animals do not become immune to them.—*W.W.M.*

Below: Teamwork: Dr. Wood (foreground) fills a syringe with bacterin (a culture of bacterial organisms in which the bacteria are subsequently killed by a chemical such as formaldahyde) while Dr. Cysewski holds a vial of aflatoxin. Their respective areas of expertise in erysipelas and mycotoxins were combined for this series of experiments on toxin consumption and disease resistance in swine (0577X582–32).

Rumen bacteria and botulism

RUMEN BACTERIA may eliminate evidence of botulism poisoning in cattle and sheep if diagnosis is delayed.

These bacteria break down proteins in the digestive process and likewise degrade the toxins, also proteins, produced by *Clostridium botulinum*. Breakdown in laboratory tests at 99° F. was complete in about 4 hours. Toxin was not inactivated when rumen contents were stored at 32° F. or lower temperature.

When botulism poisoning of ruminants is suspected, ARS microbiologist Milton J. Allison therefore suggests prompt sampling of rumen contents and storage at 32° or lower until analysis. Dr. Allison is with the National Animal Disease Center (P.O. Box 70, Ames, IA 50010).

Botulism is not a common disease of ruminants, he says. The rations fed are not often contaminated, and their ability to break down the toxins also helps explain the infrequent occurrence in ruminants. Nevertheless, botulism may be suspected in unexplained cases of poisoning.

This study, with Stephen E. Maloy and Ruth R. Matson of USDA's Animal and Plant Health Inspection Service, helps explain observations of Australian scientists. They found the lethal dose of the toxin for cattle by oral administration may be as much as 100 times the lethal dose when the toxin is introduced subcutaneously.

These tests at the National Animal Disease Center indicate the bacteria, but not protozoa in the rumen, break down the toxin, and that detoxification takes place within the bacterial cells.—*W.W.M.*

Manure makes cents

IF THE PRICE is the same for both, 10 tons of manure will fertilize sorghum better than 250 pounds of anhydrous ammonia per acre on irrigated clay soils in the Southern High Plains.

This is the conclusion of soil scientists A. C. Mathers and B. A. Stewart, USDA Southwestern Great Plans Research Center, (Bushland, TX 79012), who conducted a 3-year study comparing manure with anhydrous ammonia.

The manure, obtained from a nearby feedlot, contained from 1.1 to 2.2 percent nitrogen, up to .56 percent phosphorus, and about 50 percent moisture.

Sorghum grown on soil where feedlot manure was incorporated 8 inches deep with a moldboard plow averaged 7,000 pounds of sorghum per acre compared to 6,500 pounds per acre where anhydrous ammonia was chiseled into the soil.

The scientists attributed the extra yield to increased water infiltration during irrigation on the soil fertilized with manure.

The study also showed that runoff water quality was not affected by either the anhydrous ammonia or the manure applications.

"Our research showed a practical and safe way to utilize feedlot manure," the scientists said. "The manure improves water infiltration from irrigation in addition to supplying plant nutrients."—*B.D.C.*

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Bagging the brown dog tick

EVEN WITH THE high price of coffee, it's safe to say that brown dog tick tea would be nobody's cup.

But the "tea bag" technique is no doubt even less popular with the ticks themselves.

Using this technique, by which ticks placed in envelopes similar to ordinary tea bags are dipped in pesticides, two ARS scientists tested the effectiveness of 31 compounds in killing the ticks.

A wide variety of compounds are currently used as sprays, dusts, shampoos, and collars to treat dogs directly and to treat kennels, doghouses, lawns, and infested homes.

If left untreated, dogs and doghouses can become heavily infested with the brown dog tick which causes discomfort to the dog as well as weight loss and unsightly appearance. The dogs can also bring ticks into homes where they are a serious nuisance.

The tests are further warranted at this time because the brown dog tick is the only tick species in the United States known to have developed resistance to some pesticides.

The tea bag technique involved placing 20 engorged ticks in each bag and dipping them for 3 seconds in each of 31 different compounds.

Entomologist William J. Gladney and laboratory technician Charles C. Dawkins of the U.S. Livestock Insects Laboratory (P.O. Box 232, Kerrville, TX 72028), found that the most effective compound tested was a synthetic pyrethroid, FMC 26021. Phoxim, chlorphoxim, and permethrin were second, third, and fourth most effective, respectively. These compounds are not currently registered for use on animals by the Environmental Protection Agency. The least effective compound tested was arsenic followed by crufomate and coumaphos.

The synthetic pyrethroids may, in further tests, prove especially effective in treating dogs, doghouses, and kennels in light of recent experiments that show their outstanding residual effectiveness against flies on cattle.—*B.D.C.*

Nematode control important

SORGHUM-SUDANGRASS hybrids and millet are good hosts for many species of nematodes and so make poor summer cover crops unless nematode control measures are taken.

In research at the Georgia Coastal Plain Experiment Station (Tifton, GA 31794) nematologist A. W. Johnson and geneticist Glenn W. Burton studied the effects of four nematicides on populations of five species of nematodes and on the growth and yield of selected sorghum-sudangrass hybrids and millet.

The nematicides used in the study were of two types, volatile and granular.

The volatile nematicides, DD and ethylene dibromide, were injected 10 inches into the soil with chisels 12 inches apart at rates of 20 and 5 gallons per acre, respectively.

The granular nematicides, phenamiphos and aldicarb, were incorporated into the top 4 to 6 inches of soil with a tractor-drawn rototiller at the rate of 6 pounds of active ingredient per acre.

Generally good stands of all varieties were obtained from the treated plots, but stands were poor in the nontreated plots.

In the first yield taken, nematicide treatments increased average yield of all varieties by 65 percent, and increased the average yield of all varieties by 35 percent at the second harvest 7 weeks later.

Ethylene dibromide and DD were more effective than phenamiphos and aldicarb in increasing total yields of all varieties (73, 56, 44, and 40 percent, respectively) over the nontreated controls.

Interestingly, nontreated top-yielding millet varieties had a 179 percent greater yield than the nontreated sorghum-sudangrass, indicating the sorghum-sudangrass is more sensitive to injury by nematodes than the top-yielding millets.—*V.R.B.*

When reporting research involving pesticides, this magazine does not imply that pesticide uses discussed have been registered. Registration is necessary before recommendation. Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if not handled or applied properly. Use all pesticides selectively and carefully.

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